

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of

Report on the Feasibility of Allowing
Commercial Wireless Services, Licensed or
Unlicensed, to Use or Share Use of the
Frequencies Between 3.7-4.2 GHz

GN Docket No. 18-122

COMMENTS OF GOOGLE LLC

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Google offers these comments to inform the Commission's report to Congress on the feasibility of allowing commercial wireless services to use or share use of the 3.7 to 4.2 GHz band.¹

I. Introduction & Summary

Google has long encouraged the Commission to promote opportunities in the 3.7 to 4.2 GHz band for commercial deployment of both terrestrial fixed and mobile technologies. By taking several specific and achievable steps, the Commission can unlock the band's potential for wireless innovation. Specifically, requiring updates and supplements to International Bureau Filing System (IBFS) listings by fixed-satellite service (FSS) registrants—a process the Commission already has initiated—will ensure the accuracy and sufficiency of data to inform Commission decision-making.

Amendments to Part 101 Rules would allow expanded use of fixed links, including by

¹ Public Notice, *Office of Engineering and Technology, International, and Wireless Telecommunications Bureaus Seek Comment for Report on the Feasibility of Allowing Commercial Wireless Services, Licensed or Unlicensed, to Use or Share Use of the Frequencies Between 3.7-4.2 GHz*, GN Docket No. 18-122 (rel. May 1, 2018).

point-to-multipoint (P2MP) services, on a non-interfering basis with FSS services. Once coexistence challenges between mobile and FSS services have been resolved, designated spectrum in the 3.7 to 4.2 GHz band can be exclusively licensed for mobile use.

II. The Commission Should Collect Accurate Data to Assess Incumbent Operations and Opportunities for Shared Use of the Band²

Most of the current occupancy in the 3.7 to 4.2 GHz band is by FSS receive-only earth stations used for program distribution, the locations of which may be registered in IBFS. The band is also allocated on a co-primary basis to the fixed service (FS), but is lightly used for this purpose due to the difficulty of coordinating long-haul, point-to-point (P2P) fixed links with FSS incumbents.³

Any Commission action on the 3.7 to 4.2 GHz band should begin with improving the accuracy of IBFS. As Google has explained, analysis of Google Earth imagery of 4,724 IBFS-registered C-band FSS sites indicates that nearly 29% of registered

² The arguments in this section previously have been presented in detail in the following submissions: Comments of Google LLC and Alphabet Access in GN Docket No. 17-183 at 3-7, 11-12 (filed Oct. 2, 2017) (Oct. 2017 Comments); Reply Comments of Google LLC and Alphabet Access in GN Docket No. 17-183 (filed Nov. 15, 2017) (Nov. 2017 Reply Comments); Reply Comments of Google Fiber Inc. in RM-11778 at 3-4 (filed Jan. 24, 2017) (Jan. 2017 Reply Comments); Comments of Google Fiber Inc. in RM-11778 at 9-10 (filed Jan. 9, 2017) (Jan. 2017 Comments); Letter from Austin C. Schlick, Director, Communications Law, Google LLC, to Marlene H. Dortch, Secretary, FCC in GN Docket No. 17-183 at Attachment 5-6, 10 (filed Feb. 12, 2018) (Feb. 2018 Letter); Letter from Stephen E. Coran, Counsel to the Wireless Internet Service Providers Association, to Marlene H. Dortch, Secretary, FCC, in GN Docket No. 17-183, RM-11791 at Broadband Access Coalition/Google Attachment 2 (filed Mar. 29, 2018) (Mar. 2018 Letter) (with attachments offering detailed technical analysis that demonstrates P2MP networks' ability to protect FSS operations in large, rural parts of the country on both a co-channel and non-co-channel basis).

³ Oct. 2017 Comments at 4.

locations are not being used for satellite services. The 29% figure is a lower limit on IBFS over-registration, which does not include inactive dishes remaining at registered locations.⁴

Unregistered or incorrectly registered earth stations are not entitled to interference protection. “Termination” of protection is prescribed by Rule 25.162 if an earth station is inactive or operates in a manner inconsistent with its registration. Furthermore, FCC Form 312 applicants are required to provide “true, complete and correct” registration information, and to keep the information on file with the Commission current.

The Commission’s recent public notice encouraging registration of existing FS receivers and initiating a temporary freeze on applications for new or modified FSS earth station and FS licenses at 3.7 to 4.2 GHz is a solid first step.⁵ After the 90-day window for updating registrations closes, the Commission should act on its proposal to:

require all licensees, registrants, and operators with pending applications for license or registration of FSS earth stations in the 3.7-4.2 GHz band to file a certification that the earth station was operational as of the start of the freeze and remains operational at the time of the certification along with additional technical details regarding their operations to inform the Commission’s resolution of issues raised in the inquiry.⁶

Registrations not timely confirmed should be deleted from IBFS, and Rule 25.162 should be strictly enforced, with protection permanently terminated for those locations.

⁴ *Id.*

⁵ Public Notice, *Temporary Freeze on Applications for New or Modified Fixed Satellite Service Earth Stations and Fixed Microwave Stations in the 3.7-4.2 GHz Band, 90-Day Window to File Applications for Earth Stations Currently Operating in the 3.7-4.2 GHz Band*, GN Docket Nos. 17-183 and 18-122 (rel. Apr. 19, 2018).

⁶ *Id.* at 5.

Once updated, IBFS will become a useful tool to enable spectrum sharing, as FSS earth station locations would be correct, static, and searchable, thereby allowing other services to avoid interfering with them through design and engineering.

III. Sharing Is Possible Between FSS Incumbents and Expanded FS Uses Without Generating Harmful Interference

For fixed use of the 3.7 to 4.2 GHz band, interference analysis can account for a system's location, beam pattern, combined interference power with other systems in the surrounding area, and transmitted frequency and bandwidth. This makes coordination with incumbent receive-only earth stations relatively straightforward. For mobile systems, however, coordination parameters can change rapidly. Thus, use of the 3.7 to 4.2 GHz band for mobile likely would require decommissioning FSS earth stations in the mobile service area or shifting them to other bands.

While introducing mobile use may take time, lower-power FS services can immediately coexist with FSS operations, providing gigabit-class broadband service to American homes and businesses without causing disruption to FSS. Here, geography is a help. Matching registered earth station locations with land classification categories in the National Land Cover Database shows that nearly half of FSS sites are in urban areas, while one-third are in rural areas and 17% are in suburban areas.⁷ With rural and suburban areas' greater land areas and overall low concentration of FSS sites, ample room should exist in both for fixed broadband systems in many parts of the country.

⁷ Oct. 2017 Comments at 6.

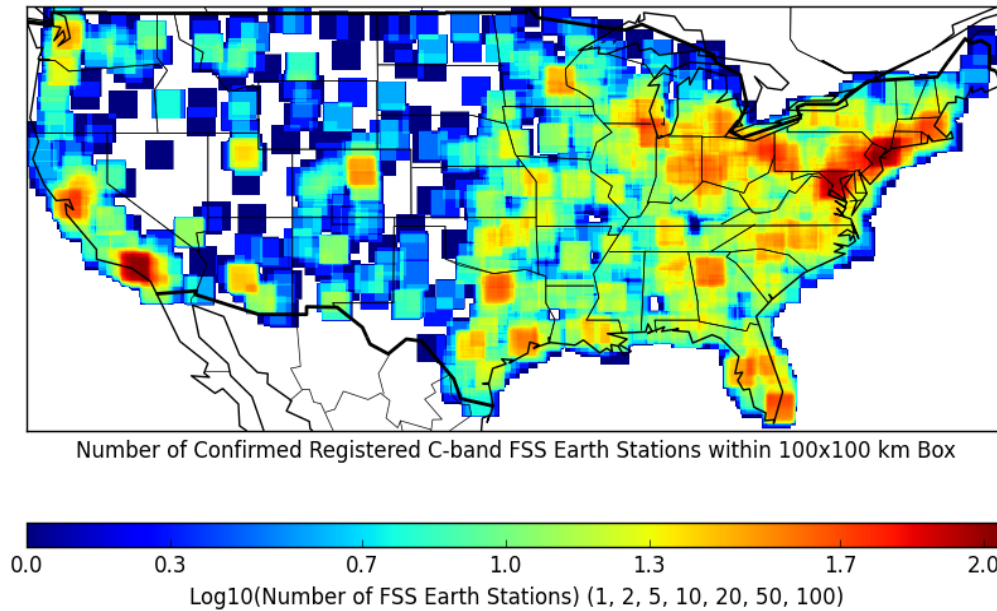


Figure 1: The number of FSS earth stations within ~100 km of each point in the U.S., based on IBFS and Google's analysis of which FSS sites actually exist. White areas have no dishes.

As discussed below, Part 101 rules can be modified to enable relatively quick deployment of P2P and P2MP systems without precluding future mobile broadband use in the band. After cleaning up IBFS, P2MP operations could be coordinated with FSS and fixed uses at 3.7 to 4.2 GHz, with exact locations and characteristics of incumbent earth stations and fixed links known, recorded, and rarely changed. With actual knowledge of FSS frequency use, frequency separation could enable P2MP broadband connectivity to as many as 120 million Americans.⁸

⁸ See Mar. 2018 Letter, Attachment 2 at 42.

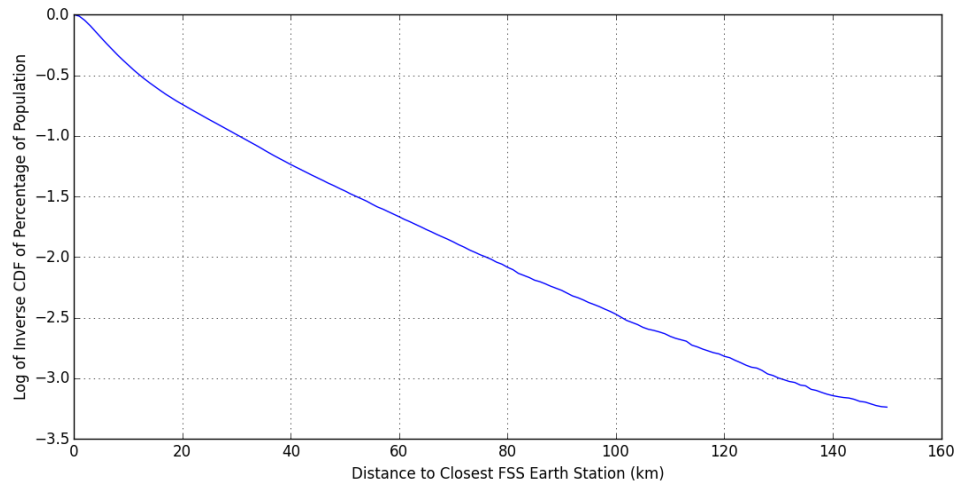


Figure 2: The fraction of the U.S. population as a function of the distance to the closest FSS dish. As much as 40% of the U.S. population (~120 million Americans) is no closer than 10 km from the nearest FSS site and could potentially be served by non-co-channel P2MP broadband.

Low-power, last-mile broadband distribution could be enabled by using P2P/P2MP connections with approximately 1 to 50 Watts EIRP. Moreover, frequency-agile fixed broadband systems could avoid interference with FSS frequencies by ensuring geographic and directional isolation, allowing for co-channel sharing. Thus, P2MP links could operate in areas that are remote from registered earth stations and also by using available frequencies and directional antennas not pointed toward nearby earth stations.

Given the extent of FSS deployments and frequency use, fixed broadband access systems would be able to use only a fraction of total bandwidth and geography in the 3.7 to 4.2 GHz band while ensuring non-interference. But the large amount of available bandwidth overall (500 MHz) makes the opportunity significant. While protecting existing links would result in “Swiss cheese” availability for frequencies and

geographies, even partial availability for P2MP systems would be better than underutilizing significant amounts of versatile mid-band spectrum.

In anticipation of future flexible use, the Commission could require FS devices to be capable of operation across the full 500 MHz of the band to ensure that new fixed operations can adapt to changing frequency plans and band allocations. Existing FS equipment not already operable across the band could be given a reasonable time to come into compliance. If and when FSS incumbents are relocated to another band, fixed broadband systems could be reconfigured to share more efficiently with post-FSS licensees.

IV. Specific and Discrete Regulatory Steps Can Enable Sharing Opportunities at 3.7 to 4.2 GHz

The Commission should take several specific and discrete steps to protect FSS registrants at 3.7 to 4.2 GHz from co-channel and non-co-channel interference while enabling sharing by other users.

A. Tailor FSS Coordination⁹

Rules for the 3.7 to 4.2 GHz band currently allow “full-band, full-arc” protection for FSS sites without a specific showing of need. FSS operators can coordinate across entire frequency bands and the entire geostationary arc visible from their location, regardless of their plans to use all of the frequencies and satellite positions. Terrestrial FS operators, however, may coordinate only those frequencies and positions they use.

⁹ Arguments in this section are presented in additional detail in the following submissions. See Feb. 2018 Letter at Attachment 6; Jan. 2017 Reply Comments at 1, 2; Jan. 2017 Comments at 5-6.

Uncritical acceptance of full-band, full-arc coordination for satellite receivers is outdated, and its use should be limited. Instead, FSS operators only should be licensed and protected in spectrum, azimuths, and elevation angles that they intend to use, with allowances for “growth capacity” and for earth stations intended to be used as part of larger networks with a need to access multiple satellites. This would make coordination between FSS and terrestrial services more equitable, and enable more efficient shared use of 3.7 to 4.2 GHz spectrum.

B. Update Part 101¹⁰

Part 101 of the Commission’s Rules should allow a greater diversity of terrestrial deployments, while still supporting and protecting long-haul microwave use and protecting FSS incumbents. Specifically:

- The Part 101 maximum EIRP formula in Rule 101.143(b) favors long-haul connections, but limits low-power, short-haul links vital to wireless broadband. Power limits should be modified to make shorter-range services viable on a non-interfering basis.
- For common carrier fixed microwave services, only P2P links are authorized, making registration of broadband networks cumbersome and costly. P2MP links also should be listed as authorized services in Rule 101.101.
- Rule 101.103(d)(2)(ii) should be updated to include location accuracy requirements similar to those in Part 96.
- As noted above, Rule 101.103 should require FS devices to be capable of operation across the full 500 MHz of the band to ensure easy adaptation to changes to frequency plans or band allocations.

¹⁰ This section summarizes arguments presented in more detail in the following submissions. See Feb. 2018 Letter at Attachment 2, 12; Jan. 2017 Comments at 1, 7-9, 10.

- Rule 101.115 should include updated antenna performance specifications allowing for broader beamwidth and lower gain.
- Rule 101.147(h) should explicitly accommodate time division duplex channels and channel aggregation.
- Broadband traffic generally peaks during the day and evening. To recognize traffic fluctuations, Rule 101.141(a)(3)(ii) and other band utilization rules that stipulate that traffic loading payload must be maintained at above 50% should be removed or clarified.
- To give providers more flexibility to introduce services, restrictions in Rule 101.131(a) on third-party access to network equipment should be relaxed.
- To accommodate more users in the band, dated license assignment and coordination processes in Rule 101.103(d)(2)(v)(C) should be streamlined. Fixed systems and FSS earth stations are particularly amenable to automated coordination, because locations and system characteristics are known and do not often change.

C. Create a Lightweight, Database-Supported Authorization Framework¹¹

The Commission should authorize a cloud-based, automated coordination system for FS links in the 3.7 to 4.2 GHz band. An automated system would modernize Part 101's manual coordination process, take advantage of current computing technology to provide more realistic propagation predictions using newly accurate data collected from IBFS, and accelerate coordination from up to 30 days to just milliseconds.

An admissions system could calculate interference using a simple algorithm. Such calculations at 3.7 to 4.2 GHz are straightforward because locations of earth stations and FS systems would be well-known after an IBFS update, and their operational parameters well-characterized. Furthermore, construction of new earth

¹¹ Arguments summarized in this section are presented in detail in the following submissions. See Feb. 2018 Letter at Attachment 10-11; Oct. 2017 Comments at 9-11; Jan. 2017 Reply Comments at 4-5.

stations is relatively infrequent and planned in advance. A lightweight admission system could work as follows:

1. The candidate FS network (P2P or P2MP) would provide terminal locations, height, bandwidth, power level, and antenna information to the coordination system.
2. Using IBFS data, the coordination system would determine aggregate signal strength from existing FS systems and either (i) provide the candidate network a maximum allowable EIRP to avoid interference, or (ii) deny the request.
3. The FS network would acknowledge the permission or revise its request.
4. The FS network could add terminals through same process.

Thereafter, the FS system would query the admission system periodically (e.g., monthly) to determine if new or deleted earth station registrations alter the FS system's operational permission. Interaction between the FS operator and the admission system could occur through (1) manual queries (typically by a professional installer) or (2) automated and standardized communications protocols, in conjunction with capabilities such as GPS or other embedded systems to ensure the FS equipment is installed in conformance with registered parameters.

V. The Commission Can Act to Facilitate Coexistence Between FSS and Mobile Services at 3.7 to 4.2 GHz¹²

As noted above, coexistence between FSS and mobile services is difficult. FSS signals travel long distances and are received at low power levels, and separation distances between mobile handsets and FSS earth stations are difficult to enforce. If interference from mobile did occur, it could be tough to locate the source. Clearing FSS

¹² Detailed presentations of arguments summarized in this section are available in the following submissions. See Feb. 2018 Letter at Attachment 14; Nov. 2017 Reply Comments at 5-7.

uses from some or all of the 3.7 to 4.2 GHz band may be the only realistic option. The Commission should investigate these issues in its upcoming rulemaking.¹³ During the pendency of any such proceeding and the ensuing implementation phase, however, the Commission should enable expanded use of the band where it can. In particular, FS expansion can occur while mobile-FSS issues are being resolved.

The mobile industry acknowledges the complexity of sharing spectrum at 3.7 to 4.2 GHz with FSS licensees and has proposed various potential paths forward, several of which involve moving FSS operations:

- Terrestrial mobile and FSS satellite operators could form commercial agreements to determine where mobile can be accommodated.
- FSS operations could be relocated to other spectrum.
- Earth stations could be confined to geographically remote areas less susceptible to interference.

In addition to the primary flexible-use allocations that would result from adoption of some such proposal, mobile service could be allowed on a co-primary basis with fixed services. Much like FSS earth stations, registered FS links are straightforward to protect and avoid, making it easy to record registration information in a spectrum management database and to ensure appropriate protection. This framework could be implemented almost immediately for P2P and P2MP fixed links after an IBFS cleanup, and very quickly for mobile upon resolution of mobile-FSS interference issues. At the end of the process, hundreds of additional megahertz of spectrum would be available for fixed

¹³ Remarks of FCC Chairman Ajit Pai at Wireless Infrastructure Ass'n Connectivity Expo (May 23, 2018), at <https://docs.fcc.gov/public/attachments/DOC-350919A1.pdf> (announcing intent to vote on a rulemaking on more intensive use of 3.7 to 4.2 GHz spectrum, including for commercial terrestrial use, at the FCC's July 2018 meeting).

links, and mobile services would have access to the full 500 MHz of valuable mid-band spectrum, including exclusively licensed spectrum and coordinated spectrum. It is hard to imagine that any other spectrum initiative could yield similarly dramatic results for wireless broadband deployment, including rural broadband, in so short a time.

VI. Conclusion

By requiring FSS registrants to update and supplement IBFS listings, the Commission has begun the process of ensuring availability of accurate and sufficient FSS data for decision-making. The Commission next should amend its Part 101 Rules to permit expanded use of fixed links, including for P2MP services, on a non-interfering basis with FSS services. Upon resolution of coexistence challenges between mobile and FSS services, exclusively licensed flexible use should be allowed, and fixed links should be repacked into the remainder of the band and/or coordinated with mobile and other exclusive flexible uses on a shared-spectrum basis.

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